Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

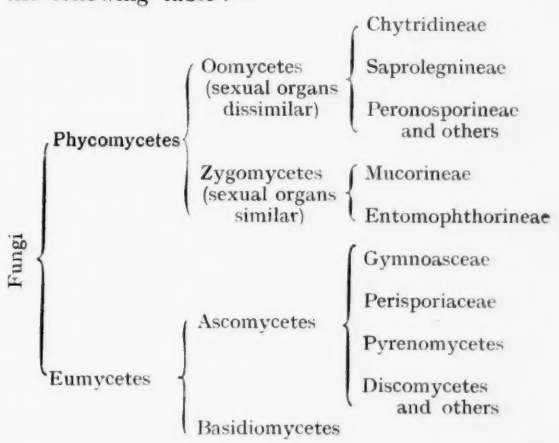
APRIL, 1916.

THE FOSSIL FUNGI.

By DAVID ELLIS, PH.D., D.SC., F.R.S.E.

CONSIDERING the comparative lack of opportunities for the study of fossil fungi, the amount of literature on the subject is surprisingly large. For the last eighty years the mill has been grinding out information, until by this time a respectable heap has been accumulated. It is true that in this body of information there is much that is not valuable and much that is doubtful; but, on the whole, its scientific value is beyond question. The vegetative body of a fungus is always in the form of delicate branching threads, called *hyphae*, which, as a rule, do not lend themselves to preservation. But it is a common experience of palaeo-botanists to find fungi in fossil wood, so that it is evident that even delicate hyphae can be preserved. Such being the case, the chances of preservation of the harder masses that fungi form must be strikingly greater. Thus the *sclerotium* of the ergot of rye is a hard mass, but it is made up entirely of fungal hyphae, and there are many instances of *masses* of fungal hyphae, all more or less hard, among representatives of the higher fungi. Then, again, the various reproductive cells (conidia, chlamydospores, and so on) must be well equipped with resistant membranes, in preparation for the ordeal which most of them have to undergo before they again find themselves in conditions favourable to germination. Finally, the fructifications which bear these spores must be of a fairly solid texture before they can fulfil their purpose. All these four types of fungal remains have been found in fossil form.

The main divisions of fungi are represented in the following table :—



It must be borne in mind that we are discussing the bygone fungi in terms of a classification that was made for the fungi as they are found to-day. That this is in any way possible is one of the best evidences that we possess of the truth of the theory of evolution; for to be able to fit fossil fungi, practically all of which have disappeared from the earth, into a scheme based on modern forms is sure evidence of a close genetic alliance.

For purposes of reference it will be necessary to insert the main geological epochs, and the following table will enable the reader to see at a glance the

horizon from which any fossil under description was drawn:—

Primary	Cambrian, Ordovician, Silurian, Devonian, Carboniferous, Permian
Secondary	Trias, Jurassic, Cretaceous
Tertiary	Eocene, Oligocene, Miocene, Pliocene

Nature of Fossil Fungi Remains.

The delicate fungal hyphae have been preserved because their substance has been replaced, particle by particle, by another substance of a more durable nature. In some the replacement is of a carbonaceous nature, but in the best preserved forms oxide of iron, or calcite, has taken the place of the plant tissues. In a certain number it seems certain that a preliminary process of carbonisation has been followed by a ferruginous replacement. In many cases, again—and these are the least satisfactory of the remains—the fungal record takes the form of imprints on fossil leaves and stems, which, it is claimed, could only have been caused by the ravages of fungi. These leaves and stems are all derived from the Tertiary rocks, and, as is to be expected, the leaves from such rocks are all identical, or nearly identical, with their representatives as they are found to-day. Such being the case, the fungi parasitic on the fossil leaves can, in a general way, be referred to the families which represent them at the present day. We will take the last type of fungal remains first.

Fossil Fungi as Impressions on Leaves and Stems.

A glance at sycamore leaves after they have fallen in autumn will show the manner in which impressions of fungi are obtainable. Many of the leaves have broad black spots on them, due to the ravages of the fungus *Rhytisma*. If we imagine now the sycamore leaf to fall at a spot where mud collects, and the mud to harden, the leaf, before its decay, would leave its impression on the mud. If the mud hardened into shale, the latter would still retain an impression of the leaf. The faithfulness with which even the tiniest markings on the leaf have been reproduced—in reverse, of course—is nothing short of marvellous. The *Rhytisma* spots on the sycamore leaf, under such circumstances, would be reproduced in reverse in the shale.

On the other hand, if we imagine a willow leaf which had been attacked by one of the gall mites, e.g., *Phytoptus salicis*, to have been preserved in the same way, the leaf would likewise impart to the hardening mud an impression of the gall produced by this insect.

Throughout the early and middle parts of last century much laborious work was done on these leaf impressions; but as not a single one of the workers claimed to be able to distinguish a gall impression from the impression produced by the fructifications of fungi parasitic on leaves, it is impossible to put a high value on their work. Most of these impressions were claimed to be *perithecia*, belonging to the Pyrenomycetes. *Perithecia* are flask-shaped fungal fructifications, opening to the outside in many cases by means of a small hole at the top. From the diagrams published it is quite impossible in most cases to come to a decision as to the meaning of the majority of these impressions, but there can be little doubt that many of them must have been due to fungi, and in the case of some the diagrams indicate structures that could not have been caused by gall mites. An example is given in Figure 65. The leaf here represented was obviously infested by a fungal parasite. It is one figured by Ettingshausen, and named by him *Rhytisma Hrubeschii*. The leaf was found in Tertiary rocks, and belonged to a walnut tree. The fructification is very well defined. Not only leaves, but also stems, were systematically searched for fungal impressions. A good example is Gaudin's *Sphaeria atomica*, also from Tertiary rocks (see Figure 68). It is not, however, possible to accept any of the stem structures as fungal impressions. At any rate, they have not been proved to be such, for, judging from the published diagrams, they are all open to the objection that they might have been caused by insects.

Both in the case of leaves and stems, it must be borne in mind that in no case is there any indication of the internal structure of the so-called perithecia; nor can there be, from the nature of the case, any traces of hyphae. We must regard this type of fossil fungi as unsatisfactory, and not set too much store on general conclusions based on their examination.

Fungi in Shale.

As is well known, mud hardened into shale is the material from which the most plentiful supply of fossils has been derived. In this section we are dealing, not with the impressions left by plants in the mud before the latter hardened, but rather with the mineralised plant; that is to say, the whole of the organised substance has been completely saturated by mineral matter in solution. This mineral matter has subsequently been precipitated in a solid form. When this happens, the inner as well as the outer structure is preserved, a fact which naturally adds considerably to the value of the fossil remains. The best known of such fungi is one found by Hancock and Atthey in the Northumberland coal fields, and described in 1869. In the shale they found small lumps, one-fifth to one-third of an inch long, of various shapes, but

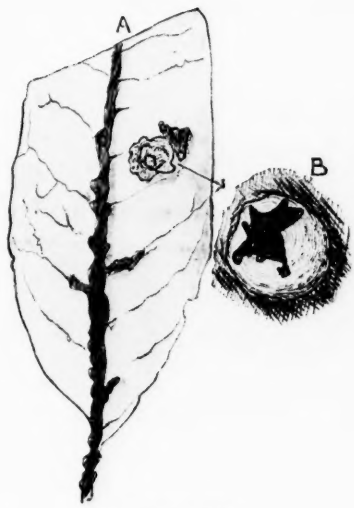


FIGURE 65.
Rhytisma Hrubeschii. (A) Natural size. (B) Perithecium magnified.

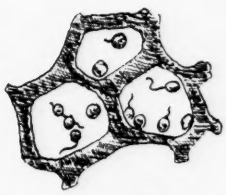


FIGURE 66.
Oochytrium Lepidodendri.

FIGURE 67.
Archagaricon ×4.

FIGURE 68.
Sphaeria atomica.
Natural size.
a = perithecia.

FIGURE 69.
Leptosphaerites Ligeae ×400.

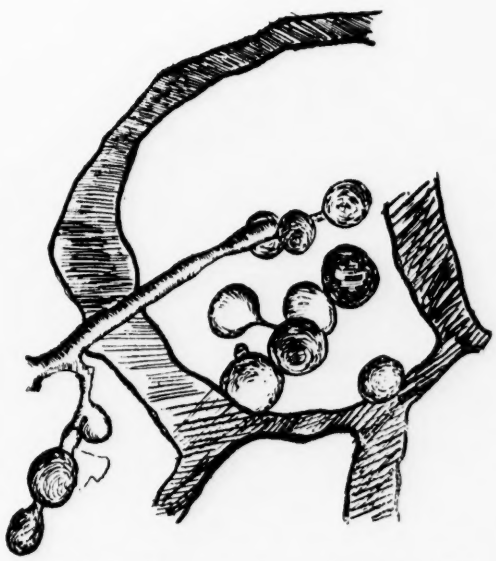


FIGURE 70. *Peronosporites antiquarius* ×350.

FIGURE 71.
Chaetosphaerites bilychnis.
×670.

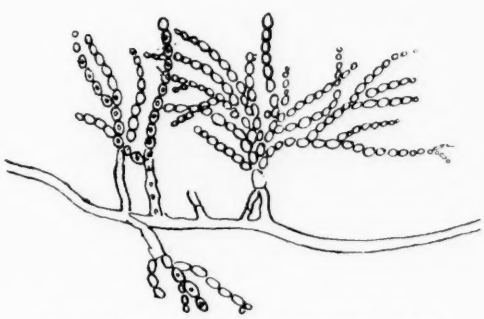


FIGURE 72. *Penicillium curtipes* ×600.

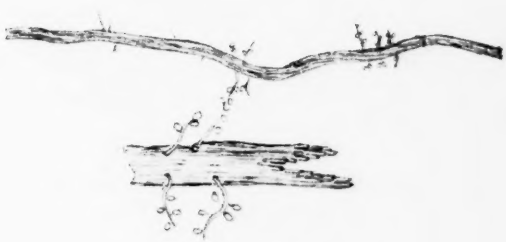


FIGURE 73.
Brachycladium Thomasinum ×600

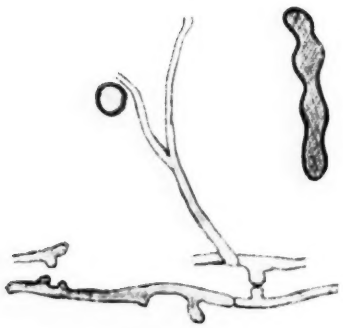


FIGURE 74.
Haplographites cateniger ×400.

FIGURE 75.
Petrosphaeria japonica ×750.

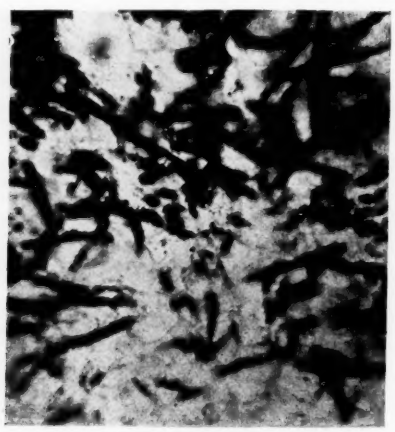


FIGURE 76.
Phycomycites Frodinghamii ×800.
Showing hyphae.

FIGURE 77.
Phycomycites Frodinghamii ×800.
(*a*) Fully developed sporangium with attached hypha (*c*).
(*b*) Young sporangium.
(*c*) Hypha which supports the sporangium (*a*).

FIGURE 78.
Phycomycites Frodinghamii ×250.
(*a*) Spore.
(*b*) Sporangium.

all of the same character (see Figure 67). When exposed they drop readily out of the shale. A microscopic examination of sections of these bodies showed that each of these lumps was made up of a mass of coiled tubular threads. The authors claim that they are resting masses of fungal hyphae, similar to the modern fungi described by Berkeley under the name of *Sclerotium stipitatum*, and which were later shown to be masses of resting hyphae, of a species of *Peziza* (a widely spread genus belonging to the Ascomycetes). The similarity between the two classes of bodies, the fossil and the modern, is very striking. Further, it must be remembered that a resting mass is a resistant mass, and there is no reason for supposing that a resting mass of hyphae could not remain a coherent mass during the process of mineralisation. The authors gave the name of *Archagaricon* to these bodies, and described several species.

The Northumberland coal fields were laid down during the Carboniferous age, a period characterised by an extraordinary activity in the vegetable kingdom. It must also have been a period of extraordinary fungal growth, for plants decay after death, and fungi are to-day, at any rate, the chief agents responsible for the scavenger work which is necessary in the economy of Nature.

SOME AMERICAN FOSSIL FUNGI.

In 1893 a fossil fungus was described which had been found by Herzer inside the fissures that obtained in the bark of certain Sigillarias. These trees are the largest of the Carboniferous plants, and there can be no doubt that then, as now, in the case of similar plants, the hyphae of fungi infested the substance of these trees. But when we read of mycelial threads that are one and a half to two inches in diameter it gives one pause to think. After all, even fossil fungi are quite similar to modern fungi in regard to the fundamental points of their structure, and hyphae of this magnitude are unthinkable. The structures mentioned by Herzer may have been bands of mycelial threads, or mineralised insect borings, or due to animal agency, but they are not single mycelial threads. The same writer describes a very interesting fungus, which he calls *Dactyloparus*. This infested the bark and leaves of Carboniferous trees, and is described as a Goliath among its relatives. So far as one can judge from the figures and description, this must have been the fructification of a gigantic Basidiomycete, that is, of the same class to which the mushroom belongs. It is a pity that the details presented to us of such an interesting form should have been so meagre. It was not like any mushroom-like fungus of the present day, yet evidently of the same family; and it is to be hoped that we shall later on be favoured with a more satisfying fare.

Among the members of the group to which the mushroom belongs are some in which the hyphae are found bound together to form tough cords, much in the same way that hempen cords are fashioned. These cords are called Rhizomorphs. They were considered at first to be separate plants, and were placed under one genus, with the name *Rhizomorpha*. Subsequently their true nature, as developmental phases of other known fungi, was ascertained, and, accordingly, the name *Rhizomorpha* was abandoned. In the Coal Measures of Ohio, Lesquereux found a fossil fungus under the bark of some Sigillarias, which he named *Rhizomorpha Sigillariae*, on account of its similarity to the rhizomorphal threads, of which mention has just been made. It must be stated, however, that in 1893 James strongly repudiated Lesquereux' interpretation. The objections of James are less convincing than the assertions of Lesquereux, but there can be little doubt that it is necessary to prove in such cases that the objects under discussion have not owed their origin to insect borings or to other agencies. As in the other American researches on this subject, there is a disappointing want of finality, which is the more deplorable because of the intrinsic interest which the material from this quarter presents.

FUNGI IN AMBER.

In the Eocene age, in certain parts of Europe, there existed an extensive forest of trees, mostly belonging to the family of Conifers. Then, as now, these plants exuded a resinous, sticky matter over the surface of the bark. The exudation picked up everything portable that happened to lie on its path, and among the things engulfed were insects, some of which were in a state of putrefaction. The process of putrefaction was straightway arrested, for resin is of an antiseptic nature. In the course of time the resin hardened into amber, and so we are able to examine the fungi, that were responsible for the putrefaction of the insects, in an excellent state of preservation. As we are dealing with Tertiary plants, we shall expect the flora to be not totally unlike that of the present day. Three species of fungi were described by Berkeley in 1848, and his descriptions are excellent. His *Penicillium curtipes* (see Figure 72) is a beautiful example. Here we see the hyphae and the asexual spores which they bore; we can form an opinion of the manner in which the spores were borne, and also of the mode of branching. The relationship of this fungus to the commonest of modern moulds, *Penicillium glaucum*, is unmistakable; and yet there is no fungus exactly like it living at the present day. Another of Berkeley's amber fungi is shown in Figure 73, and which has been named *Brachycladium Thomasinum*. The thick mass seems to have been constructed by the binding together of a large number of hyphae to form a cord, something like a rhizomorph. From this cord single spore-bearing hyphae appear to have been given off. We have nothing like this at the present day. Berendt, in 1847, described an interesting fungus in amber. The hyphae were attached to an insect

in amber. Scattered among the hyphal threads was a number of spores that had evidently been detached from the threads. This fungus was called *Sporotrichites*, on account of its similarity to the modern genus *Sporotrichum*.

Conwentz describes a fungus which he found on a small twig that had been enveloped by the resin in the same way as the insects. This particular fungus was so like the modern *Polyporus vaporarius* (one of the "Shelf" fungi) that the same specific, as well as the same generic, name has been given to it.

FUNGI INSIDE FOSSILISED WOOD.

This class includes by far the greatest number of fungi that have hitherto been found. Among modern trees a fairly large percentage is infested with fungi when still living. When trees are blown or cut down, and allowed to remain on the ground, the fungi increase rapidly inside the plant tissues. It is to be presumed that the same fate overtook the trees of the bygone ages after they had come toppling down to the ground.

As already mentioned, it is a common experience of palaeo-botanists to find fungal hyphae in fossilised plant tissues. A well-known fungus, derived from Carboniferous trees, is *Peronosporites antiquarius*, discovered by Carruthers, and somewhat inaccurately described by Worthington Smith. The hyphae traverse the tracheides of a Carboniferous tree, and at various points give rise to swellings, which are claimed to be oogonia. Smith claims to have observed spores inside the oogonia, and also to have recognised transverse walls in the hyphae, but all subsequent writers state that this is inaccurate. The hyphae and swellings generally regarded as oogonia are in a beautiful state of preservation. The original slides are in the possession of the British Museum, and the drawing in Figure 70 was made from one of these slides. We can claim for this organism that if it did not belong to the genus *Peronospora* it at any rate belonged to the group to which the modern *Perenospora* belongs, viz., the Phycomycetes. Among the discoveries of the gifted French scientist, Renault, we may reckon a number of fungal organisms which he found in the tracheides of Carboniferous trees. One of these is *Oochytrium* (see Figure 66). The hyphae and reproductive cells of a fungus which was parasitic in the tissue of a *Lepidodendron* plant are clearly shown. In the reproductive cells of the same plant was also found another fungus, in the form of a mass of hyphae, which is stated to belong to the same family as our white mould (*Mucor*). We could extend our survey of the fossil fungi that have been found in the Primary rocks, and mention other organisms, but amongst them all there is no single indubitable case of the hyphae and reproductive cells found belonging to either the Ascomycetes or Basidiomycetes. This may be due to insufficient research, but it may be due to the fact that in these very remote periods the higher fungi had not been evolved. Among the American fossil fungi *Dactyloparus*, described above, may be one of the higher fungi, but our knowledge is too uncertain at present to permit of definite assertions to be made about it. With regard to the Secondary rocks, no fossil fungi are known, with the exception of the one described below. The examination of the Tertiary rocks, however, has uncovered a preponderating number of fossil fungi, belonging to the higher groups. This holds, for example, in Felix' excellent work (1894) on the fungi which he found in the vessels of Tertiary plants. We may instance *Perisporiacites Larundae*, *Leptosphaerites Ligeae* (see Figure 69), and *Chaetosphaerites bilychnis* (see Figure 71). It will be noticed that the generic names resemble the names of modern genera, excepting that the termination "-ites" is added, to indicate that it is a fossil genus. This, again, is only another illustration of the close similarity that exists between Tertiary fungi and those of the present day—a similarity that, taken as a whole, by no means extends to fungi from the Primary rocks. In Felix' work we have also an excellent example of a fossil fungus from one of the lower groups of fungi. This is the organism he calls *Haplographites cateniger* (see Figure 74), from the Eocene rocks of South Russia.

We will close this section with a reference to the recent work of Stopes and Fujii (1910). These authors found resting masses of hyphae inside the vessels of Tertiary plants from Japan. The hyphae, which were septate, and measured 2–4 μ, at various points formed nests of thickened cells. These appeared to be the beginnings of the formation of resting masses, which took the form of round or oval masses, made up of dark brown "cells," with thickened walls. The name *Petrosphaeria japonica* was given to this organism, and its appearance is shown in Figure 75. Here, again, there is no difficulty in matching this Tertiary fungus with a modern fungus. Among the modern Sphaeriaceae these resting masses are not uncommon. Similar resting masses were obtained by Salmon (1903) from the Sicilian Tertiary rocks. It seems as though mineralisation had set in by replacement of the organic matter by oxide of iron, which, of course, would easily explain the fact of the preservation.

A FUNGUS FROM THE SECONDARY ROCKS.

The writer has recently (1914) found a fossil fungus in the Jurassic rocks of Lincolnshire. There has hitherto been no case on record of a fossil fungus from any of the Secondary rocks. This fungus was found in the Frodingham ironstone, which is Oolitic in parts, and also very richly supplied with organic remains. The fungus in question apparently owed its preservation to the fact of its membrane being replaced by oxide of iron. Hyphae, sporangia, and spores are shown in

Figures 76 to 78. The hyphae are about 2 μ in width, and show no transverse walls. It was not possible to specify any order among modern fungi to which it was obviously related, but it was evidently a member of the family Phycomycetes. It was accordingly named *Phycomycites Frodinghamii*. In addition to being the sole representative of the Secondary rocks, it is also unique in being the only fossil fungus known which flourished in sea water; for the Jurassic rocks, of which this ironstone forms a part, were laid down under marine conditions. Competent mineralogists, who have seen the slides, admit the organic origin of the structures in question, and the only other possible rival interpretation is that insect borings may have been responsible. If insects bore into trees, and their borings become filled with mineral matter, it can readily be seen that the appearance presented by fossil fungal hyphae might be imitated; but an insect that bores a hole a five-hundredth of a millimetre in width, and then imitates, not only sporangia, but also the spores in organic connection with the latter (see Figures 76 to 78) must indeed be a remarkable creature. The structures in question may, then, fairly be claimed to be fossil fungi, and as such are of exceptional interest.

CONCLUSION.

It has not been possible to do more than take a general survey of the different types of fossil fungi, for, in spite of the very small advances that of late years have been made in our knowledge, the total output is considerable. It has been shown that fossilised fungi are known to us as simple hyphae, as resting masses, as reproductive organs, and as reproductive cells. When we review the available data, it becomes evident that, of the copious material presented by the Primary and Tertiary rocks, sufficient evidence is shown to permit of the conclusion that the higher fungi predominated in the Tertiary rocks, and that these are scarcely, if at all, represented in the Primary rocks. It is not clear that the higher fungi were not represented in the Primary age, but it is clear that they were not predominant then, and also that they were predominant during the Tertiary age. Questions of phylogeny cannot be discussed with the material we have at present, especially as so much of it is of a doubtful nature, and because the Secondary rocks have so far yielded only one fossil fungus; but sufficient is known to justify a hopeful augury for the future. At present, however, this cannot be done, so we are not justified in "taking the offensive."

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

NEUJMIN'S COMET.—The first cometary discovery of 1916 was made by Mr. Neujmin on February 24th at the Simeis Observatory, Crimea. The discovery was made on a photographic plate in the course of the search for minor planets, which is part of the routine work of the Simeis Observatory. We may note parenthetically that some seventy new planets were discovered last year, that eight hundred and seven planets have now received permanent numbers, and that many long-missing planets have been lately recovered, notably No. 99, Dike, missing since 1868, the year of its discovery.

Mr. Neujmin has already discovered several comets. One (1914 *c*) was interesting from its very large perihelion distance, 3·743 units (this is exceeded by one comet only, that of 1729, whose perihelion distance was 4·051 units); another (1913 *c*) was interesting from its unusual period, eighteen years, a value that seems to designate it a member of Saturn's family. The present comet was found on February 24th, some 6° south-west of Mars. Apparently its proximity to the ruddy planet was actual, not merely optical, as they seem to have been at the same distance from the Earth.

Professor Backlund has telegraphed the following orbit of the new comet: Perihelion passage, February 23·140, Greenwich M.T., omega 180° 10′, node 324° 57′, inclination 18° 26′, log perihelion distance 0·2113. These are still uncertain, as they are based on a very short arc, but I have used them to compute the following ephemeris:—

	R.A. h. m. s.	S. Dec. ° ′	Log r.	Log Δ.
April 9	9 28 13	2 23	0·2409	9·9878
,, 17	9 39 2	4 32	0·2508	0·0246
,, 25	9 50 51	6 27	0·2618	0·0620

At discovery the comet was photographically of the eleventh magnitude, but Mr. W. H. Steavenson stated that it was visually of the eighth or ninth magnitude, and had a well-defined nucleus. From the character of the orbit it would not be surprising if the comet proved to be one of short period.

GRAVITATION.—The interesting article on "Astronomy and Modern Novelists" in "KNOWLEDGE" for February contains the following sentence, referring to Mr. Wells's "First Men in the Moon": "The sphere leaves the Earth of itself, since its presence (with blinds down) renders all the air above it weightless, and the pressure of the surrounding atmosphere sucks it violently upwards." Mr. Wells made a somewhat remarkable oversight in this connection, which apparently escaped Mr. Ling's detection. Since the resultant attraction of the Earth acts towards its centre, Mr. Wells assumed that the whole force between the Earth and an object above it takes place along the line joining their centres, so that the interposition of a small plate of the imaginary substance "cavorite" would block out the whole force. But in reality every particle of the Earth's substance is pulling the body towards it, and the pull towards the centre is simply the resultant of trillions of pulls, whose lines of action fill a cone-shaped figure.

Now, returning to our sheet of "cavorite," it is clear that at a height of a few inches above it practically the whole of

XUM

the Earth's pull would be cut off, but that a few feet higher a considerable fraction of the pull would be available, the lines of force passing outside the sheet; and that at a height of a mile the diminution of pull would be about as trivial as would be the amount of the broad landscape visible below that was covered by the sheet of "cavorite." In other words, the statement that the whole column of air above the sheet of "cavorite" would lose all its weight and rush off into space is seen to be a huge fallacy; and I differ from Mr. Ling's statement that "all the properties deduced by Mr. Wells follow quite logically and convincingly."

I lately received a pamphlet from S. Raby on Newton's Seventy-seventh Proposition, in which the author thinks he has discovered a flaw of an elementary nature in Newton's proof. In reality he has himself read Newton's enunciation with great carelessness, and has assumed that Newton is dealing with attractions varying according to the inverse square; whereas Newton says clearly in the enunciation that he is dealing with attractions varying as the direct distance. The proposition establishes that homogeneous spheres attract each other as though the mass of each were concentrated at its centre. It is well known that this law holds both for attraction varying as the direct distance and for attraction varying as the inverse square of the distance. But naturally the proofs for the two forms of attraction differ. In the case of the inverse square it is shown that a thin spherical shell attracts any external particle as though all its mass were concentrated at its centre, while it exerts no attraction on any internal point. Thus any solid sphere attracts external particles as though all its mass were concentrated at its centre. It is not necessary that the sphere be homogeneous. Provided each shell is homogeneous, one shell may differ from another in density according to any law we please. This beautiful proposition was discovered by Newton, and greatly simplified the dynamics of the solar system, since it showed that all spherical bodies were dynamically equivalent to particles at their centres. Thus lunar and planetary theories are practically problems of particle dynamics, with the addition in some cases of terms arising from equatorial protuberance.

THE FIRST ACCURATE DETERMINATION OF LONGITUDES.—M. G. Bigourdan, Assistant at the Paris Observatory, has drawn attention, in the *Comptes Rendus de l'Académie*, to the first good determination of the difference of longitude between Marseilles and Alexandria, which was based on an eclipse of the Moon observed in August, 1635. Ptolemy had made a map of the whole of the world known to him, but there was very great distortion in longitude, since he took the circumference of the Earth as eighteen thousand miles, discarding the earlier and more accurate value (twenty-five thousand miles) found by Eratosthenes. Eclipses of the Moon form an excellent way of getting approximate longitudes. The beginning and end of an eclipse can be timed to a minute or thereabouts. They take place at the same instant for all points on the Earth's surface where the eclipse is visible, so all that is necessary is to find the local time of the beginning or end of the eclipse at each station, which can be done by measuring the altitude of known stars. This method was explained by Hipparchus; but nearly one thousand eight hundred years seem to have elapsed before it was practically applied. Nicolas Claudius Fabricius (otherwise known as Peireskius), after observing the lunar eclipse of 1635, March 3rd, planned that the one of August following should be observed at Padua, Caesenna, Rome, Naples, Cairo, and Aleppo. This scheme was successfully carried out, and the result showed that Aleppo was only 32° east of Marseilles, instead of 45°, as had previously been supposed. The narrative continues: "The matter being therefore apparent, Peireskius called together a company of seafaring men, and so explained the problem that they were amazed; and, being questioned about the particular distances, they freely granted that, of two thousand seven hundred miles commonly reckoned between Marseilles and Alexandria, at least five hundred might be abated."

It is difficult to credit how so huge an error should have been tolerated in such well-known seas only two hundred and eighty years ago.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon), F.I.C.

OXIDISING POWER OF SOILS.—A method of measuring the oxidising capacity of soils has been devised by Mr. F. C. Gerretsen (*Bull. Agricul. Intelligence and Plant Diseases*, 1915, VI, 1583). A weighed quantity of the soil is shaken with an acidified solution of potassium iodide, the amount of iodine liberated estimated by titration with thiosulphate, and the result calculated upon 100 grammes of the soil. It was found that the oxidising power of soils thus indicated depended upon the amount of iron present and upon the presence or absence of oxidising enzymes, or oxydases. In the case of certain soils thirty to forty per cent. of the total oxidising capacity was due to oxydases. Aëration of the soil, even by exposure to the air for a short time, increased its oxidising power, and a special relationship could be traced between the oxidising capacity and the growth of plants in the soil.

UTILISATION OF KITCHEN REFUSE IN GERMANY.—Dr. A. Frank, writing in the *Journ. Prakt. Chem.* (1915, XCII, 419) throws light upon the thoroughness with which the Germans have organised every detail in connection with their food problem. So far back as November, 1914, the Prussian Home Secretary directed the attention of the authorities of the towns in Prussia to the necessity of utilising kitchen refuse. Practical tests showed that when this was rapidly dried in a suitable plant it was disinfected and concentrated, and when used as a feeding stuff for cattle had a food value of 67·3 to 68·3 per cent., as compared with 67·9 per cent. for fodder barley. Since then it has been made obligatory on every householder to separate material suitable for fodder from paper and other unsuitable refuse.

A further improvement suggested is that the fat, which is estimated at about twenty grammes per head daily, should be extracted from the refuse, and that the waste heat from the gas works should be used for working the plant. In 1913 the gas works in Berlin produced upwards of three hundred and thirty-three million cubic metres of gas from about nine hundred and seventeen thousand tons of coal, from which was obtained about six hundred and forty thousand tons of coke. About fourteen per cent. of this coke was used for heating the retorts, or about half as much again as was necessary. Estimating the amount of kitchen refuse at two hundred and fifty grammes per head daily, the waste heat of the gas works, even during the summer period of lowest production, would be more than sufficient to dry the material and work the plant. It is also suggested that this source of heat might be utilised for drying potatoes for food and for treating trade refuse, such as brewer's grains.

ALLEGED FORMATION OF PERSILICIC ACID.—Experiments made by Komarowsky indicated that a salt of the hypothetical persilicic acid was formed by the action of hydrogen peroxide on sodium silicate, and his conclusions were supported by Jordis, who observed an odour which he believed to be chlorine on exposing a solution of sodium silicate to the air. The question has now been investigated by Dr. H. Ditz (*Journ. Prakt. Chem.*, 1915, XCII, 412), who has found that no trace of hydrogen peroxide is produced when sodium silicate solution is exposed to the air for three months. In his opinion the odour attributed to chlorine was probably the odour of nitrous gases absorbed from the air. Moreover, any manganese (which is a common impurity in sodium silicate) would be oxidised by atmo-

spheric oxygen, and would then decompose hydrochloric acid with the liberation of chlorine. The proofs of the existence of persilicate cited by Jordis are therefore inconclusive.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., B.Sc.

THE PERU-BOLIVIA BOUNDARY.—Although the boundary between Peru and Bolivia, which had been in dispute for eighty years, was settled by the Argentine award of 1902, the actual demarcation was hindered by the lack of knowledge of the area in question. The republics concerned invited the assistance of the Royal Geographical Society, and a number of British officers were appointed to determine the boundary. Unfortunately, two of these—Captain Toppin and Lieutenant Moores—have been killed in France, and, as the others are engaged in military service, a summary of the results has been published by Sir T. Holdich (*Geog. Jour.*, February). This account gives an excellent idea of the enormous difficulties under which the work was carried out; and when the nature of the country and the type of boundary are considered, it is wonderful that such success attended the efforts of the workers. So long as the work was confined to the central Andean range triangulation was feasible, if not easy, despite adverse meteorological conditions. In the foothills, or "Montana," however, the conditions were very disagreeable and the work difficult and dangerous. The Montana are "densely forest-covered, clothed deep with the débris of past generations of rotting vegetation, pathless except for the rubber tracks, reeking with mist and moisture, and alive with pestiferous insects." Additional difficulties arise from the fact that, owing to the rubber interests, it is necessary to cut an actual boundary track, and in future years to keep this line clear. The ever-present mists, too, render the taking of observations exceedingly troublesome. It is interesting to note that Toppin ascribes the inefficiency of the natives to their indulgence in cocaine.

SIR CLEMENTS MARKHAM.—By the death, on January 30th, of Sir Clements Markham, geography loses one of its most energetic and enthusiastic exponents. He initiated his exploring work as a member of the Franklin Search Expedition, and followed this with investigations, extending over several years, in Peru. One of the most important consequences of the latter was the introduction of the cinchona plant into India. Later he accompanied the Abyssinian Expedition as geographer. He, however, is more known through his numerous writings and his great efforts to advance the science of geography. As successively Secretary, Vice-President, and President of the Geographical Society, he was connected, in some capacity, with most of the explorations of the last half-century; while it was mainly due to his efforts that the schools of geography in Oxford and Cambridge were founded. To his great interest in Polar explorations may be traced the origin of several expeditions, culminating in the two which were commanded by Captain Scott, and which achieved such remarkable results. His facile pen was responsible for numerous volumes, including thirty of the invaluable publications of the Hakluyt Society, as well as a large number of papers and memoirs (*Geog. Jour.*, March).

GEOLOGY.

By G. W. TYRRELL, F.G.S., A.R.C.S.

THE INORGANIC CONSTITUENTS OF BRACHIOPODS AND CORALS.—In continuation of their extensive research relative to the inorganic constituents of marine invertebrates, F. W. Clarke and W. C. Wheeler have contributed notes on the chemical composition of the hard parts of Brachiopoda and Corals (*Proc. Nat. Acad. Sciences*, Washington, May and November, 1915). The object of the investigation is to determine what substances are contributed by each group of organisms to the marine sediments, and therefore to the formation of marine limestones, with special reference to their magnesian and phosphatic varieties.

The Brachiopoda fall into two groups: one calcareous, the other highly phosphatic. The first consists of calcium carbonate with little organic matter; the second of predominant calcium phosphate (seventy-five to ninety per cent.), with much organic matter. The two groups, although they may be alike structurally, are physiologically quite dissimilar, the chemical reactions involved in building their shells being of two different orders. The biologists are invited to investigate the meaning of this distinction. Geologically the phosphatic brachiopods have probably played some part in the formation of phosphatic sediments, a function shared by vertebrates and some crustaceans.

Thirty analyses of zoantharian corals have confirmed previous work on the chemistry of these organisms. These corals consist mainly of calcium carbonate, with minor impurities, and a little organic matter. The same is true of the coralline Hydrozoa. The Alcyonaria, however, differ considerably from these in containing from six to sixteen per cent. of magnesium carbonate and often calcium phosphate. Many of them are rich in organic matter. A remarkable relation holds between the proportions of magnesium carbonate and the temperature of the water in which the organisms are found, the proportion of this constituent increasing with the temperature. Consequently a deficiency of magnesium carbonate occurs in corals from high latitudes or from deep waters. The same relation has been shown to hold for the Echinodermata ("KNOWLEDGE," Volume XXXVIII (1915), page 275).

EOCENE GLACIAL DEPOSITS IN COLORADO.—At the north-western base of the San Juan Mountains, near the town of Ridgeway, Colorado, W. W. Atwood has found a series of exposures, including a section of glacial till, which is overlain by formations of Early Tertiary age (United States Geological Survey, Professional Paper 95, B, 1915). The formation consists of two members. The lower, a good boulder clay, is bright yellow in colour, and contains numerous typical, faceted, striated, and grooved stones. It has a maximum thickness of ninety feet. The upper member is thinner, and is described as a pebble till, with few and small stones. The formation rests upon a Cretaceous shale, which is too loose and soft to have received or retained glacial striae. It is overlain by an Eocene conglomerate; but occasionally this is absent, and its place is taken by the next formation, the San Juan tuff, which is also of Eocene age. The glacial deposits are believed to have been formed by Eocene glaciers, descending from the lofty ancestors of the present San Juan Mountains. This record leaves only the Ordovician, Silurian, Jurassic, Oligocene, and Pliocene periods without some evidence of glacial action.

MODE OF FORMATION OF IGNEOUS BRECCIA.—In a paper on the geology of the district between Abereiddy and Abercastle, Pembrokeshire (*Quart. Journ. Geol. Soc.*, Vol. LXXI, Part II, 1916), Dr. A. H. Cox describes what is perhaps a new mode of igneous brecciation. A series of keratophyres (soda-rich igneous rocks of trachytic affinities) occupies a fairly definite horizon in the *Tetragraptus* beds (Arenig). They are intrusive, as they have generally hardened the shales in contact with them at each margin. The relations between the igneous and the adjacent sedimentary rock are peculiar and complicated. They pass one into the other at both margins by a thick zone of breccia, consisting mainly of igneous material near the intrusion, but with an increasing quantity of sedimentary rock farther away. This gradual transition between an igneous and a sedimentary rock is accompanied by a correlative change in the degree of hardening of the shale by contact metamorphism. As the proportion of sedimentary material in the breccia increases, the hardening becomes less and less apparent, and finally

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disappears. Occasionally small fragments of the igneous rock are found in the adjacent slates many yards from the parent mass.

Dr. Cox advances the explanation that the keratophyres represent lavas which tended to burrow into the mud of the sea-floor. The covering of mud was so slight that the escaping gases caused a brecciation of the igneous rock at a time when it had become practically solid, fragments being thrown to a considerable distance. When these fragments were few in number they would cause little alteration in the mud into which they fell; when more abundant, and of larger size, a greater degree of hardening would be caused. The mud which became involved with the main mass of igneous material would be intensely baked and hardened, just as are the sediments in the fissures of the Old Red Sandstone lavas of Scotland ("KNOWLEDGE," Volume XXXVII (1914), page 31). On this theory, however, it is difficult to understand how the layer of breccia underlying the lava was formed.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.Met.Soc.

THE WINTER CLIMATE OF THE EASTERN MEDITERRANEAN.—In his Presidential Address to the Royal Meteorological Society Major H. G. Lyons, F.R.S., directed attention to a subject which must exercise great influence on the naval and military operations now in progress, namely, the winter climate of the eastern Mediterranean. During the last fifteen or twenty years a large number of meteorological stations have been in operation, and from their published results we have an accurate and detailed knowledge of the conditions which prevail there at the different seasons of the year. These may vary from the true Continental climate of the Balkans, with its low winter temperatures and moderate rainfall at all seasons, to the Mediterranean climate of Southern Greece and the Levant, with its mild winter, hot summer, and a strongly marked rainy season in winter. In Lower Egypt these characteristics also prevail in a more intense form. The geographical character of the Balkan Peninsula and the surrounding seas, Syria and Palestine, and Lower Egypt affect to some extent the general climatic conditions. The temperature in the Balkan region is frequently very low, descending to 0° F., and often below this at many stations; while frost occurs often at inland Greece, and occasionally throughout the eastern Mediterranean. The most severe weather occurs when anticyclonic conditions, with clear skies and light wind, prevail in the Balkans. The air then falls to a very low temperature, and as a result streams off the highland down into the low-lying Aegean Sea as a strong cold northerly wind, which often reaches gale force. January is the coldest month, and February differs but little from it, the first marked departure from winter conditions occurring in March. By this month, too, the waters of the Mediterranean begin to grow warmer. During the winter months they have been from 5° to 10° F. warmer than the coasts, where, therefore, the winter climate is much milder than inland; but in March the difference becomes very small, and disappears at many places as the land is growing rapidly warmer. In winter rainfall is heaviest on the western shore of Greece and Syria, and markedly less on the eastern coasts. The Balkan rainfall has a maximum in November, and afterwards decreases slightly, but it is not heavy at any time. Rain falls during the passage of depressions from the Mediterranean, which pass from west to east bringing clouds, mild weather, rain, and strong winds. Rainfall decreases southward, and in Lower Egypt the amount is insignificant. The normal air circulation of the eastern Mediterranean is simple in its general outlines. Northerly winds blow over Greece and the Aegean Sea, becoming north-westerly in the Mediterranean and westerly on the Syrian coast. In Egypt northerly winds prevail. This arrangement, which follows from the mean distribution of pressure in winter, is, however, greatly modified by the frequent passage of depressions along the Mediterranean from west to east. Many pass over the Balkans to the Black Sea and Southern Russia, causing strong southerly gales in the Aegean Sea, with rain and mild, unsettled weather for two or three days. Others, again, pass to the south of Greece, sometimes skirting the Egyptian coast, and cause south-easterly gales and stormy weather in the eastern Mediterranean and Levant, and northerly winds in the Aegean Sea. An analysis of the observations shows that northerly winds, which cause rough sea in the Aegean Sea during the winter months, are more frequent than southerly winds in the proportion of 2·5 to 1; and, since many of these northerly winds are due to cold air pouring down from the Balkan highlands, the northerly winds may continue for a week at a time, while southerly gales rarely last for more than two days unless a second depression is closely following the first.

FLOODS IN HOLLAND.—A large part of Holland has been inundated by disastrous floods owing to the collapse of the dykes in several places on January 13th. During that day a very deep barometric depression was centred off the coast of Norway, which caused a very heavy gale from the north-west over the North Sea. This gale forced the water in a south-easterly direction, and drove it against the coasts of Holland and into the Zuider Zee, with the result that the tide rose to a tremendous height. This increased pressure of water, intensified by the breaking of the violent waves, caused breaches in the dykes, which the Dutch had built up years ago for the reclamation of the land from the sea. The water over many parts of the Polder—as the reclaimed land is called—rose to a height of twenty-two feet. The intensity of the gale is shown by the fact that at 7 a.m. on January 13th the barometer reading at Aberdeen was 29·48 inches and the wind west-north-west, force 9, while at Skudesnaes it was as low as 28·70 inches, and the wind east-south-east, force 10; that is, a difference of barometric pressure of 0·78 inch in a little over three hundred miles. A similar disastrous inundation occurred on February 3rd, 1825; and also in the year 1717, when it is reported that one thousand three hundred persons were drowned.

MICROSCOPY.

By F.R.M.S.

ON A NEW METHOD FOR THE MICROSCOPICAL EXAMINATION OF ROCK SECTIONS.—The following method of illumination of rock sections for microscopical examination may prove useful in rendering inconspicuous details more visible than when they are viewed in the ordinary way. First, it may be mentioned that it is not so easy to apply "critical microscopy" to ordinary petrological work. If "critical microscopy" denotes that the image of the flame of a paraffin lamp is focused by a substage condenser on the object, so that it forms an axial cone of illumination whose aperture is three-quarters that of the objective on the nose-piece, and if "ordinary petrological work" means the examination of rock sections under polarised light with powers of fifteen to seventy-five diameters (three-inch to one-inch objectives and A or B eyepieces), then it is clear that the impossible is soon reached, for the following reasons:—

1. If the substage condenser is of high power (which is usually the case in petrological microscopes), the image of the flame formed by it will be so small that an insufficient area of the object will be illuminated.

2. If the substage condenser is of low power (for a large-flame image one of about two-inch focus would be required), and if it has, say, 0·15 N.A., or two-thirds of the aperture of a 1½-inch objective, it follows that its back lens must be 1·2 inches in diameter. Now, as a polarising Nicol prism large enough to pass a beam of light 1·2 inches in diameter is so costly, this plan need not be considered practical.

We see, therefore, that it is not possible with petrological microscopes as now constructed to examine objects under polarised light critically with low powers, for they are fitted with small polarising Nicol prisms and substage condensers of high power, with small back lenses to suit the small areas of the polarising prisms. Usually the front lens of the substage condenser is removable, so that its power may be reduced; but, even when this is done, its power is still too high for work with two-inch and 1½-inch objectives. The dilemma remains, because if the power of the condenser is low its aperture must be very small; and if, on the other hand, it has sufficient aperture its power is a great deal too high. For example, the back lens of a petrological microscope condenser—typical of the class—has a focus of one inch, and the polarising Nicol belonging to it will pass a beam of only eight millimetres diameter; whereas the back lens of the Quekett condenser is thirty millimetres in diameter, and its focus is two inches. The following are the measurements of the image of the flat of the flame of a Hinck's paraffin lamp with a single one-inch wick :—

Usual petrological condenser with top on.	
Area of flame-image	1
Usual petrological condenser with top off.	
Area of flame-image	20
Quekett condenser with top on.	
Area of flame-image	20
Quekett condenser with top off.	
Area of flame-image	113

The above units are square $\frac{1}{50}$ inch, *i.e.*, squares of Maltwood's finder.

This table shows that a considerable area of rock section can be illuminated with the right kind of light for a critical image by means of the Quekett condenser. At the same time, it is obvious that, on account of expense, a Nicol polariser to suit it would be quite out of the question.

Other kinds of polarisers were then tried, and finally the " pile of plates " form was selected as the best (see Figure 79, P). In Powell's No. 1 microscope the cell holding the three-inch mirrors is properly made, for the ring which secures the mirrors in their place screws into the cell; therefore at any time the mirrors can be removed. In other microscopes the mirrors are burnished in—for that is the cheapest way of mounting them—so they cannot be taken out. With a Powell's microscope it is easy to take out the concave mirror (which is never wanted for any purpose) and replace it by a pile of glass discs cut from extra thin slip glass, a piece of black needle paper (which can be obtained from any dealer in photographic stores) being placed underneath them. Experiments were made with fourteen discs to determine the proper number. Seven are perhaps too few; nine act quite well; finally ten were put into the cell. As some experience a little difficulty in setting the mirror, lamp, and so on, in the proper position, the following method may be found helpful. Cut out of a post card an obtuse-angled scalene triangle, with an obtuse angle of 113½°; place the obtuse angle on the plates with the short side of the triangle in the optic axis of the condenser; then the long side will indicate the position for the lamp flame (Figure 79, PL_1S shows the arrangement). After the instrument has been set up a few times in this manner it is quite easy to remember the relative positions of the lamp L, mirror P, and so on. The card triangle may therefore be dispensed with, for it does not take thirty seconds to place the apparatus correctly. Of course, the exact position is finally tested by the darkness of the field when the analyser above the eyepiece is rotated. Usually it is preferred that the fiducial line in the eyepiece for measuring angles should be vertical. This means that the long diagonal of the Nicol should be horizontal. Now, although the plane of polarisation with a " pile of plates " cannot be rotated, yet it is possible to arrange matters so that the fiducial line may be vertical with a dark field. This is managed by adjusting the height of the lamp flame from the table, when the microscope is inclined to a comfortable position for work. If the microscope is a small one, it will have to be raised up on a block of wood, so that its optic axis may be ten inches from the table when the tube is horizontal. If this condition is fulfilled, then, when the microscope is inclined to a comfortable angle for work, it will be easy to adjust the height of the lamp so that the plane of polarisation will be the same as that from a Nicol, which has its long diagonal horizontal.

Analysers are of four kinds: the Nicol, the Glan Thompson, and the Tourmaline (all these fit above the eye lens of the eyepiece); the fourth is the Abbe, which fits between the lenses of the eyepiece. The next table shows the areas

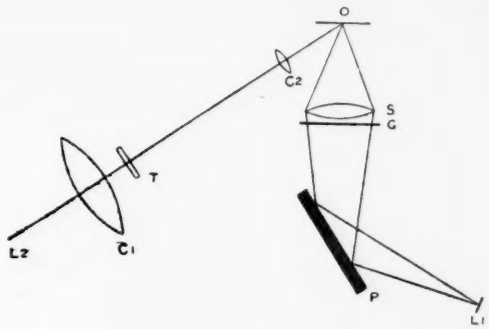

FIGURE 79.

of the field with the various analysers in terms of the squares of Maltwood's finder ($\frac{1}{50}$ inch) as before.

Tourmaline, No. 1 Powell A eyepiece, area ...	133
Glan Thompson ,, ,, ,, ...	120
Nicol ,, ,, ,, ...	78
Abbe Continental ,, ,, ,, ...	50
Glan Thompson Continental ,, ,, ,, ...	38

The difference between the areas of the fields of a No. 1 Powell with a two-inch eyepiece and a Continental with a No. 2 eyepiece is apparent.

With a slide of ordinary Aberdeen microcline granite on a Powell's microscope, a two-inch objective and A eyepiece (power 25), an average-sized quartz crystal, together with its surrounding crystals, is taken into the field at one time; whereas with a Continental microscope and the same power a quartz crystal more than fills the field. The drawback with the Nicol and Glan Thompson analysers is that, if the field is large, the prism must be long; therefore the eye is kept a good distance from the eye lens of the eyepiece. This objection is removed in the Abbe form; but then the field is small, and a prism is required with each eyepiece. The Tourmaline is really an excellent form of analyser, but it must be of the brown variety. It acts like a neutral tinted-glass eyeshade. This is an advantage when large axial cones of illumination are used; otherwise the image is too bright to be pleasant for the eye. With a Glan Thompson analyser, if the image is too bright, a neutral tint glass should be used.

The drawback concerning the " pile of plates " polariser is that it cannot be rotated like a Nicol; but, on the other hand, critical images are obtained with low powers, which cannot be got in the usual way.

The Quekett condenser (see Figure 79, S) is shown by a simple equiconvex lens, but in reality it is an achromatic combination, and an achromatic front lens fits on for work with higher powers.

The " pile of plates," when not placed at the polarising angle, makes a capital plane mirror for ordinary microscopical work by daylight, such as the examination of insect preparations and similar objects; for it acts as a light-subduer without colouring the image. The usual and

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erroneous method of subduing the light when excessive is to cut it down by closing the iris, which, of course, yields an uncritical image. A better plan is to use a neutral-tinted screen. Ground glass is sometimes placed at the back of the condenser to soften the light; but this, again, entails a loss of definition. Many other devices, such as plaster of Paris and opalescent glass, have been used for this purpose, but undoubtedly the "pile of plates" is best. This, however, is a digression. To return to Figure 79, two lenses will be seen on the left-hand side. These are for the purpose of condensing an oblique beam from a second lamp L_2 (flame edgways) on to the object O. C_1 is an equiconvex lens 3·1 inches in focus and 1·8 inches clear aperture. C_2 is another equiconvex lens 2·4 inches in focus and 1·2 clear aperture. These lenses are mounted 12½ inches apart upon an aluminium rod. A pin, which passes at right angles through the rod about its centre of gravity, fits into an ordinary lens holder. This apparatus is placed relatively to the lamp flame L_2 and the object O, so that the edge of the flame is four inches from C_1; then, if a card is held three inches on the other side of C_2, a bright disc of light, half-inch in diameter (an image of C_1), will be formed.

This apparatus was designed by the writer, both for this purpose and also as an illuminator for opaque objects. One more thing is necessary, namely, to place a light blue-green screen G below S. This unfortunately darkens down the polarised beam and also colours it slightly; nevertheless, it adds greatly to the effect of this kind of illumination.

Now, if the arrangements enumerated above are properly carried out, and a two- or half-inch objective is used, with an A or B eyepiece, and a specimen of, say, Aberdeen microline granite is placed on the stage, and a crystal of biotite brought into the centre of the field and rotated, so that the oblique beam falls at right angles to the laths of the biotite, the biotite will probably light up in a surprising manner, looking as if it were composed of gold tinsel, with a strong light shining upon it. Some crystals of biotite shine up in this way better than others. The crystal under examination should be rotated, so that the oblique beam falls first on one side and then on the other side of the lines of cleavage, for they will probably shine up on one side and not on the other. Shap granite (Adamellite) looks as if it had been sprinkled over with fine gold dust. Hyperite, from Maud Junction, shows interesting details, for in some of the crystals of plagioclase, at right angles to the twinning, bright lines appear which give a beautiful effect. These lines when viewed in the ordinary manner are often inconspicuous. Lines which cause the iridescent sheen on some minerals, such as Labradorite, are beautifully shown, and appear like the bright lines seen in a good spectroscope. As this kind of illumination renders the lines of cleavage very conspicuous, it is interesting to note that in some specimens these lines of cleavage run more or less parallel through various crystals in the section, just as if the crystals had arranged themselves in such a way as to satisfy this condition. This can be very well observed in augite syenite of the Monzoni type. Actinolite exhibits lines of extraordinary brightness, so that they are quite dazzling to the eye. I have never before seen anything like it in a microscope.

THE QUEKETT MICROSCOPICAL CLUB. — The five hundred and fourteenth Ordinary, which was the fiftieth Annual Meeting, was held on Tuesday, 22nd February, 1916, at 20, Hanover Square, W., the President, Professor Arthur Dendy, D.Sc., F.R.S., in the chair.

Series of mounted objects, comprising sponge spicules, diatoms, and foraminifera, were exhibited under microscopes by Mr. W. E. Watson Baker. These all displayed some interesting characteristic feature, either in the method of mounting or in the specimen itself. The special business of the Annual Meeting was then proceeded with. The Committee's Report (including those of the Secretary of the Excursions Sub-committee the Librarian, and the Curator) was read, and disclosed a very satisfactory condition, in spite of the many difficulties caused by the war. There was a small increase in the membership, and the attendance at the meetings showed only a very slight diminution. The papers read had been well up to the usual standard, and at the gossip meetings the display of objects had not been reduced. The President delivered his annual address entitled "Some Factors of Evolution in Sponges." It dealt largely with the development of the spicules in the various classes of sponges, and was necessarily of a technical character. A verbatim report will appear in the next number of the Journal of the Club.

PHOTOGRAPHY.

By EDGAR SENIOR.

COLLODIO-BROMIDE EMULSION FOR LANTERN SLIDES.—Our notes in the February issue of "KNOWLEDGE," which dealt with the variation in tone that could be obtained in transparencies made upon collodio-bromide plates, have led to some enquiries being made as to whether such plates are obtainable commercially. Although we believe that plates of this nature are no longer articles of commerce, we may state, for the benefit of those who may desire to try their hand at making lantern slides by this process, but without having to go through the ordeal of making the sensitive material, that Messrs. Penrose & Co., of 109 Farringdon Road, E.C., supply a collodion emulsion ready for immediate use, which in our hands has given excellent results. It is very necessary, however, that the glasses which are going to be employed for coating with the emulsion be made chemically clean, and to this end they should be soaked for a few hours in—

(1)

Potassium bichromate	400 grains
Water	10 ounces
Sulphuric acid	1 ounce

They must then be well rinsed under the tap, and finally with distilled water, after which they are set up to dry. Before coating the plates with the emulsion a substratum of some kind must be applied. The following one will be found satisfactory:—

Gelatine	100 grains
Acetic acid	1 ounce

This is put into a bottle and warmed until solution takes place.

(2)

Chrome alum	20 grains
Water	1 ounce

To prepare the substratum the solutions are mixed in the following proportions: No. 1, five parts; No. 2, one part, after which seventy parts of methylated spirit are added and the solution filtered. The mixture is then applied to the glass in the same manner as collodion, and the substratum allowed to dry. Before coating the glass plates with the emulsion, the bottle containing it must be well shaken for at least a couple of minutes in order to bring into suspension the silver bromide which has settled to the bottom. The emulsion is then allowed to remain at rest for a short time before being used. For the purpose of coating, the glass plate is held in a horizontal position upon a pneumatic holder, when a small pool of the emulsion is poured on, and the plate gently tilted first to the right-hand top corner, then to the left, and after this to the bottom left-hand corner, finally allowing the excess of emulsion slowly to drain back into another bottle, while rocking the plate from right to left in order to avoid streaks. As soon as the emulsion has set, which is ascertained by the impression of the finger being formed upon the thick edge of the film, the plates may be stood up in a rack to dry, which in a warm room they will do in a very short time. The coating of the glass with emulsion, and all subsequent

operations, may be conducted in a bright yellow light. The exposure of the plates may either be made by contact, or in a reducing camera, and the image developed with glycin, using a formula such as the following :—

Glycin	...	...	...	6 grains
Sodium sulphite	...	...	10	,,
Potassium carbonate	...	...	25	,,
Water	...	...	...	1 ounce

Development is usually completed in about three minutes, the image being then fixed in a twenty-per-cent. solution of "hypo," and afterwards washed for three or four minutes under the tap, and then dried spontaneously or in front of a fire. We may say in conclusion that we found the emulsion give a very structureless film and a fine rich image free from fog.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.S.

ELECTRO-MAGNETIC VACUUM BALANCE.—The electro-magnetic balance, as an instrument for accurately determining the intensity of an electric current, is well known. Anderson (*Faraday Soc. Trans.*, October, 1915) proposes to utilise it to replace the chemical balance. For the scale pan of a chemical balance upon which weights would normally be placed is substituted a horizontal circular coil of wire. This coil is between two larger fixed coils, having the same vertical axis. An electric current flows through the movable coil and lowest coil in one direction; then through the highest coil in the opposite direction, so that the electro-magnetic forces necessary to balance the object being weighed may be obtained by suitably adjusting the current. The whole balance is enclosed in a bell-jar, which can be evacuated.

STROBOSCOPIC METHOD OF DETERMINING THE VELOCITY OF A FLAME.—In the course of an investigation on the electrical conductivity and luminosity of flames containing salt vapours H. A. Wilson (*Phil. Trans.*, No. 63, 1915) employed an elegant method of finding the velocity of the current of burning gas constituting a flame. A series of puffs of salt spray injected into the flame produced an upward moving column of bright patches. On viewing the flame through the holes in a rotating disc these patches may be made to appear stationary. The distance as seen through the holes in the stroboscope between two patches is that traversed between two successive injections of salt, so that the velocity of the flame is this distance multiplied by the frequency with which the injections are made. On applying a downward electric field the positions of the puffs are unaltered, so that the luminous vapours in a Bunsen flame are not deflected by an electric field.

PHYSICAL PROPERTIES OF ISOTOPES.—Isotopes are elements which have the same chemical properties, but different atomic weights. Thus several isotopes of lead are known, which differ in atomic weight, but are chemically inseparable. Soddy found that lead from thorite had a higher density and higher atomic weight than ordinary lead. Richards and Wadsworth find (*Journal of the American Chemical Society*, XXXVIII, No. 2) that the atomic weight and density of lead from Australian radio-active minerals are both notably lower than those of common lead. The density of common lead is 11·337, and that of the material containing the isotope of smaller atomic weight 11·288. The authors propose to study other physical properties of lead and its isotopes. We hope that soon these bodies, though chemically inseparable, may yield to some method of physical analysis.

EXPERIMENTS WITH GLOW-LAMP FILAMENTS.—If the "pip" of an ordinary incandescent lamp be broken off, and the bulb filled with paraffin oil, it provides a most satisfactory resistance. It is able to absorb more power than with a vacuum, and also to stand momentary overload much better. When sufficient current is used bubbles form on the filament, but these, instead of rising to the surface, run down the legs against gravity, and come off at the bottom. Dr. Smith, in repeating the above experiment, which is due to Mr. Addenbrooke, discovered another and more striking phenomenon. If the voltage applied to the lamp were reduced, so that no bubbles formed, it was possible (by momentarily increasing the voltage) to obtain a single bubble upon the filament. The behaviour of this bubble was most fascinating to watch. It ran backwards and forwards from one terminal to the other, "looping the loops" of the filament many times before escaping from the wire. Dr. Smith gives a theory of this effect, which can be obtained with direct or alternating current, and in various liquids. (*Proc. Phys. Soc.*, Lond., Vol. XXVIII, Part I, 1915.)

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

COLLOID CHEMISTRY.—A translation has recently been published of Wolfgang Ostwald's "A Handbook of Colloid Chemistry." The translator is Dr. Martin H. Fischer, of the University of Cincinnati. It is not clear from the book whether the translator has kept closely to the German original, or whether, as seems probable, he has made additions on his own authority. On page 98 some remarkable statements about radio-activity appear. We are told that "the emanations of radio-active substances may be *much* increased if they are highly dispersed, as by being converted into colloid form. These authors [Wedekind and Baumhauer] succeeded in preparing radio-active thorium in colloid form. . . . The radio-activity of the sol [thorium] was 4·8 times as great as that of the coarsely dispersed element. The extraordinary significance of this discovery lies in the fact [that] it has not as yet proved possible to influence markedly the emanation from a radio-active substance by any other means, as by raising the temperature, etc."

In a footnote to this paragraph the author of the book states that the "extraordinary significance of this discovery" was not recognised by the authors themselves (Wedekind and Baumhauer).

It is deplorable that in a book which ought to aim at accuracy, published by a well-known firm, a writer, who obviously does not know the difference between thorium and thorium emanation, should sweep away with such confidence the whole theory of radio-activity founded by many scientists, and based on careful experimental work. One would have thought that such a writer would have obtained someone conversant with the facts of radio-activity to read over his manuscript before allowing it to go into print.

INFLUENCE OF FOREIGN SUBSTANCES ON THE ADSORPTION OF URANIUM-X BY CHARCOAL.—In 1909 Ritzel published an account of an experiment in which he found that if a solution of uranium-X was shaken with charcoal or soot the radio-element was adsorbed by the latter substance. If, however, a trace of a thorium salt was present in the solution, the adsorption was inhibited. A consideration of the facts of this experiment helped to lead to the conception of isotopes. Ritzel's experiments have now been considerably extended by Freundlich and Kaempfer (*Zeitsch. physik. Chem.*, 1915, page 681), and Ritzel's results have, in general, been confirmed. It is found, however, that other substances besides thorium, such as zirconium, benzoic acid, strychnine nitrate, and basic dyes, have the power of inhibiting the adsorption; but there is always some significant distinction between the action of these substances and thorium. This bears a close resemblance to the experiments of the present writer (*Trans. Chemical Society*, 1913, Volume 103, page 381), in which he found that cerium, as well as thorium, will inhibit to a certain extent the adsorption of uranium-X by barium sulphate; but treatment with acids will dissolve the

XUM

uranium-X from the barium sulphate in the thorium experiment, but not in the case of cerium.

One interesting fact brought to light by the present paper is that if charcoal containing adsorbed uranium-X is shaken with a thorium solution, the uranium-X is actually forced out of the charcoal into the solution.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

HABITS OF SILVER-FISH.—Major J. W. Cornwall has made a careful study of little silver-fish insects, supposed to be *Lepisma saccharina*, which did much damage to books, papers, and pictures in the Pasteur Institute of Southern India. They avoid the light; they run along quickly with many sudden pauses; they are gregarious. They can remain without food for over a hundred days. They eat paper, paste, sugar, cloth, and the dead bodies of their neighbours. Nothing but concentrated vapours and gases will destroy the adults. Bits of camphor and naphthalene have no effect. A monthly cleaning of books and papers is recommended.

AN EARTHWORM THAT SQUIRTS.—A new earthworm, found in the Belgian Congo by Dr. Cuthbert Christy, has been described by Mr. H. A. Baylis under the name *Dichogaster jaculatrix*, n. sp., and the specific name refers to its habit of squirting when irritated. When lifted in rat-tongs they sent out, probably from the large dorsal pores, jets of opalescent and slightly viscid fluid. Dr. Christy reports that the jets were ten or twelve inches high. The worm can make a second discharge in a few minutes, and even a third. The cuticle of the living animal shows a bright green and blue iridescence, and beneath the cuticle each segment is marked dorsally by a purplish transverse band. The worms may be a little over a foot in length, and go down for several feet into the red clay of the forests. Their red chimney-like casts, which stick up four or five inches among the dead leaves, are sometimes baked by the Bahayru miners, and used as tobacco pipes.

ILLUMINATION OF THE DEEP SEA.—In his interesting reminiscences of Woods Hole Marine Laboratory Professor Edwin Linton gives us some vivid "snapshots." Speaking of the abyssal fishes brought up by the trawl, he writes: "A strange world was opened up to the imagination by these creatures from the depths. Fish with eyes living in those regions whither the light of day cannot penetrate! Whence comes the light which the presence of organs of sight implies? Gorgonid corals, slender and fragile and as delicate as the finest grasses of autumn, shining in shadow with a brilliant phosphorescent light, suggest that if we could see this ocean floor we would see it dimly illuminated by the phosphorescence of its living denizens, among them groves of gorgonians, motionless in the currentless water, and shining with a light literally not seen on sea or land."

LEECH REMOVED FROM NASAL CAVITY OF A SOLDIER FROM THE DARDANELLES.—Gideon sifted his soldiers by distinguishing those who knelt to drink the water directly from those who used the cupped hand to lift the water to the mouth, and Dr. S. F. Harmer suggests that this may have had reference to the danger of becoming infected by leeches. This danger was recently proved by the case of a soldier from Gallipoli, who was infected in the nasal cavity with the well-known *Limnatis nilotica*, of which Dr. Harmer gives an interesting account. It is very thin when leading a free existence. Larrey says it is ordinarily not thicker than a horse-hair, but this is surely an error. It becomes as big as a medicinal leech when it is gorged with blood. Infection is due to drinking water at dusk or in the dark. Once introduced, the leech takes up a position from which it does not readily allow itself to be dislodged.

HIGH TONE IN BABOONS.—In a recently published book on "Instinct and Intelligence" Dr. N. C. MacNamara tells of the parental affection of baboons, and his observation tallies with a story of Brehm's which Darwin quoted. Near Colgong, on the Ganges, Dr. MacNamara saw a troop of baboons seated on a ledge of rock, and among them a female with a young one beside her. "One of our party, without a moment's thought, fired and killed the young ape: its body rolled down the rock, and was instantly followed by the older ape, evidently the young one's mother. On reaching the dead body she took it up in her arms, fondled it, and uttered the most piteous wail, which attracted a crowd of her companions, several of whom joined her in her lamentations." Dr. MacNamara says that the behaviour of these apes indicated "a distinctly high tone of instinctive action." In a circumstance so unusual the term "instinctive" seems to us to be singularly inappropriate.

THE VEGETABLE-MARROW PLANT.

LAST month we gave some notes on the external structure of the vegetable-marrow seed and seedling. We now offer some illustrations (see Figures 80 to 82) showing the microscopical details of the embryo. In the cross-section of the seed-leaves (see Figure 80) it will be noticed that the palisade tissue is already differentiated from the mesophyll, in which, however, the air-spaces present in the ordinary foliage leaf have not made an appearance. A section of the full-grown leaf is given in Figure 83 for comparison. The longitudinal section of the plumule and radicle (see Figure 81) is particularly interesting. It shows, of course, both growing points and the root-cap, but the growing point also of a young side root is also visible. The details of some of the cells of the seed-leaves and their food contents are shown in Figure 82. A favourite object for demonstrating a typical cell, and the movements of the protoplasmic body within, is one of the coloured hairs from the flower of *Tradescantia*, but we venture to think that one of the green hairs from the outside of the young flower bud of the vegetable marrow, under good conditions, gives better results. Figure 84, of which the parts are labelled, shows a cell from such a hair; and if the temperature is right, and the hair uninjured, the movements of the protoplasm can be seen most excellently. W. M. W.

THE STOAT OR ERMINE.

ONE of the interesting features of the stoat is that it still continues in this country, here and there, to change its brown coat for a white one in the winter. A noteworthy specimen received in the flesh by the writer, some time ago, from Monmouthshire, was entirely white as regards the body; while the tip of the tail, which, as a rule, remains quite black, had only a few black hairs left in it. The existence of these was additional evidence (the eyes being pigmented) that the animal was not an albino. Fertile mules are rare in the animal kingdom; but it may be worth while to mention that Mr. Alfred Heneage Cocks reared five generations of a hybrid between the stoat and the ferret. He did not make the original cross himself. This was done by a railway signalman. As a matter of fact, Mr. Cocks, who has had great success with the majority of the British carnivora, has not found the stoat very easy to keep in captivity.

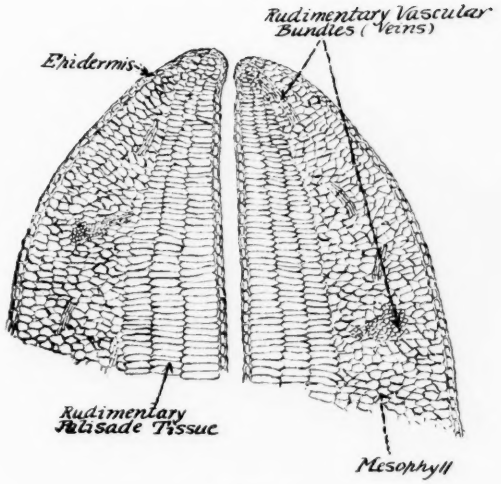

FIGURE 80.
A cross-section of the seed-leaves.
This may be compared with Figure 83.

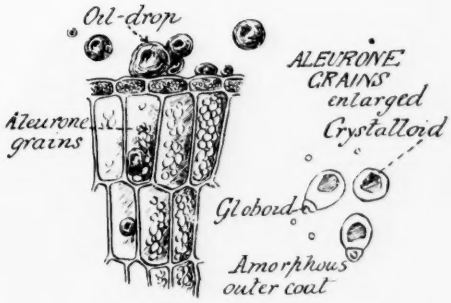

FIGURE 82.
Food material in the cells of the seed-leaves.

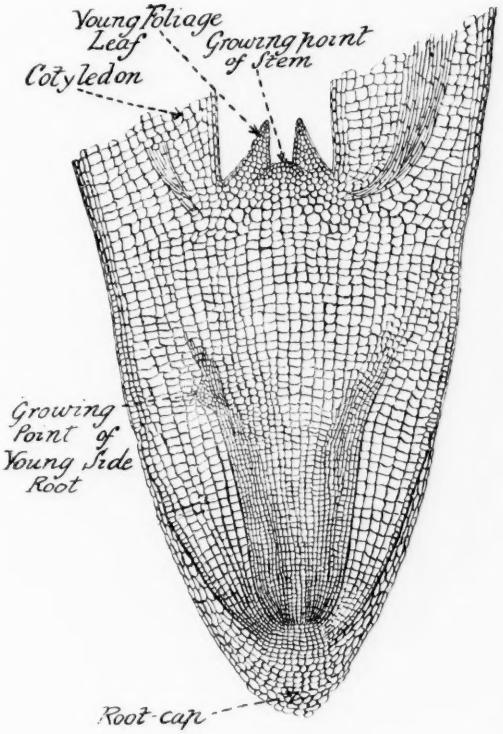

FIGURE 81.
Longitudinal section of part of the embryo.

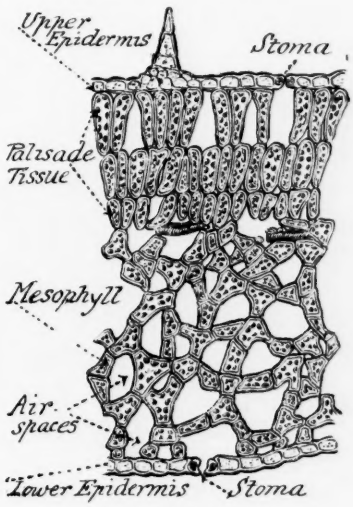

FIGURE 83.
A section of a foliage leaf.

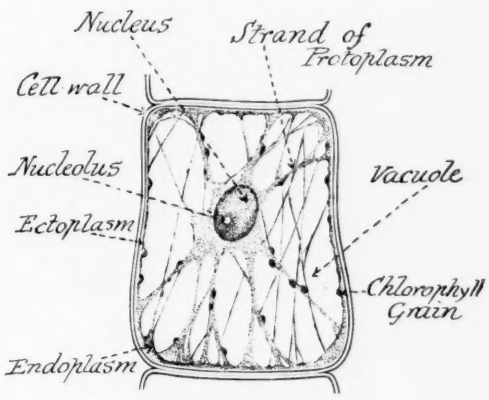

FIGURE 84.
One of the cells of a hair from a flower-bud.

THE VEGETABLE-MARROW PLANT.

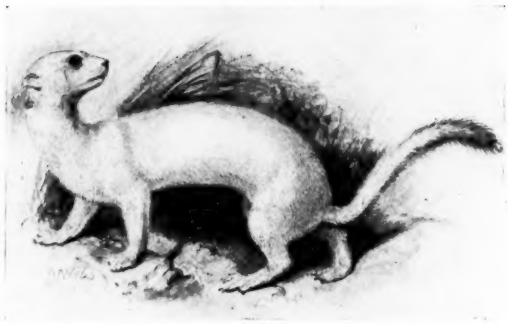

FIGURE 85. A Stoat in which the winter whitening had affected even the tip of the tail.

FIGURE 86. Two Stoats in a cage.

FIGURE 87. A Stoat kept in captivity for two-and-a-half years.

At one time the writer, hoping that he might possibly repeat the cross between the stoat and the ferret, reared some young stoats by hand. Unfortunately the only male, being stronger than his two companions, pushed his way out of the cage, and the experiment came to nothing; but the two female stoats were kept as a matter of interest, and one lived for two years, and the other for six months longer. For some time they were tame enough to be handled, but afterwards, having been left alone, they were too spiteful to be made pets of. They soon gave over the habit of emitting their foetid smell, except when they had a fit (which they did from time to time), when the muscles of the stink-gland were accidentally relaxed. Figure 86 shows the two stoats coming out from the straw, in which they hid, to see a visitor, and Figure 87 illustrates one of them exposed to view. It is a mistake to think that stoats must be fed on blood and soft food, for the specimens mentioned above subsisted almost entirely on butcher's meat, and it is likely that if their diet had been a little more varied they would have lived longer still. W. M. W.

REVIEWS.

CHEMISTRY.

Organic Chemistry.—By V. von RICHTER. Translated by P. E. SPIELMANN, PH.D. 719 pages. 9-in. × 6-in.

(Kegan Paul, Trench, Trübner & Co. Price 21/- net.)

This, the first English edition of von Richter's well-known work on the chemistry of the carbon compounds, presents all the excellent features of the German original. The book will be useful to the chemist engaged in research, while for the student the first sixty-eight pages will be valuable as an introduction to the study of organic chemistry.

In dealing with certain well-defined groups of carbon compounds, full advantage has been taken of the work of experts in the several branches.

The treatment of a few of such subjects may be instanced.

The purine group is dealt with at considerable length, and the classical syntheses of uric acid are clearly described. Further, the relationship of uric acid to other members of the purine group is clearly expressed. It is unfortunate, however, that more attention is not paid to the lengthy series of investigations carried out by Emil Fischer and his collaborators, which resulted in the establishment of the exact configurations of the different members of this interesting group of compounds. From the historical point of view a more detailed description of the Strecker method of decomposition and von Baeyer's synthesis of the pseudo-uric acid derivatives would have enhanced the value of this account.

The chemistry of the sugars is adequately treated, and the account given of this complicated subject is clear. The space-isomerism of the various members of the group is well and fully described, as is, indeed, the whole subject of isomerism.

The section dealing with animal substances of unknown constitution is, perhaps, the least satisfactory feature of the work. In view of the recent important developments in the subject of colloid chemistry more attention should have been paid to this matter.

It is interesting to find in this book a protest from a Frenchman recorded by the German editors against a system of nomenclature which has "conduit rapidement à des termes bizarres, d'une complication fâcheuse et d'une prononciation difficile."

The index, always a valuable feature in a work of this type, is carefully compiled.

Dr. Spielmann is to be congratulated on having made a most excellent translation, and it is to be hoped that the publication of the second volume of this work will not be too long delayed. J. P. M.

Catalysis and its Industrial Applications.—By E. JOBLING. 120 pages. 12 illustrations. 7-in. × 6-in.

(J. & A. Churchill. Price 2/6 net.)

The growing importance of catalytic process in various branches of industry makes it desirable to have a collected account of such processes.

In the present work the author describes the outlines of the principal industries in which the phenomenon of catalysis plays a part, and in this sense the work is a useful one.

Comparatively little attention is paid to the theory underlying the various processes, and it is to be hoped that the author in a further work may realise this, and discuss at greater length such reactions as those of Grignard and Friedel and Craft. J. P. M.

Modern Chemistry and its Wonders.—By GEOFFREY MARTIN. 351 pages. 36 plates. 29 drawings. 7-in. × 5-in.

(Sampson Low, Marston & Co. Price 7/6.)

This book, like a previous one by the same author, presents many features of interest to the layman who has no special knowledge of chemistry. The book is simply and clearly written, and, so far as such a thing is possible, free from technicalities.

At a time like the present, when the thoughts of everyone are turned towards war, details as to the nature and manufacture of explosives are to be welcomed. This subject is clearly and well treated, and the author shows how, by making use of atmospheric nitrogen, the Germans are independent of the Chile saltpetre supply.

Such subjects as the chemistry of coal tar and the phenomena of radio-activity are well discussed, and the whole work provides an interesting and popular account of one of the romantic sides of chemistry.

Some of the plates are excellent, and the diagrams are clear. J. P. M.

SPECTROSCOPY.

Collected Papers on Spectroscopy.—By G. D. LIVEING AND SIR J. DEWAR. xvi+566 pages. 10-in. × 6-in. With numerous plates and illustrations.

(The Cambridge University Press. Price 30/- net.)

There is perhaps no department of natural science that can boast a more monumental and comprehensive textbook than spectroscopy, and, indeed, Professor Liveing and Sir J. Dewar, in their preface, state that all the additions to knowledge which they have contributed have been culled and classified in Kayser's "Handbuch der Spectroscopie." But a summary, however convenient, is never completely satisfying, and there is no doubt that much is lost of the ideas and methods of investigators when the results of their researches are too easily accessible in a predigested form. The collected papers of Professor Liveing and Sir J. Dewar are therefore a particularly welcome addition to the literature of spectroscopy. The papers have been published in their original form, and date back over the last thirty-eight years. The earlier papers deal largely with the phenomena of reversal, and to the writer it seems strange that so many of the important results achieved have never been followed up by other writers. As an interesting example the remarkable absorptions, apparently due to mixed metallic vapours, do not appear to have received any further attention. Many other instances of this kind might be given. The publication of the papers in a collected form should lead other workers to follow the many fruitful lines of research which they suggest.

THOMAS R. MERTON.

XUM

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 12.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Mars. R.A.	Mars. Dec.	Jupiter. R.A.	Jupiter. Dec.	Saturn. R.A.	Saturn. Dec.	Uranus. R.A.	Uranus. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
May 5.....	2 48·7	N. 16·2	5 22·6	N. 26·4	4 7·8	N. 23·4	5 58·6	N. 27·1	9 32·4	N. 16·7	1 14·0	N. 6·6	6 52·8	N. 22·7	21 28·8	S. 15·6
„ 10.....	3 8·1	17·6	9 31·3	N. 12·9	4 35·8	24·6	6 17·5	27·1	9 39·9	15·9	1 18·2	7·1	6 54·8	22·6	21 29·0	15·6
„ 15.....	3 27·7	18·9	13 29·1	S. 14·7	4 56·5	24·9	6 34·9	26·8	9 47·8	15·1	1 22·4	7·5	6 56·9	22·6	21 29·2	15·6
„ 20.....	3 47·6	20·0	18 42·2	S. 24·9	5 9·1	24·5	6 50·5	26·4	9 56·0	14·3	1 26·6	7·9	6 59·1	22·6	21 29·4	15·6
„ 25.....	4 7·7	20·9	23 17·2	S. 0·4	5 13·2	23·5	7 3·8	25·8	10 4·6	13·4	1 30·6	8·3	7 1·4	22·5	21 29·4	15·6
„ 30.....	4 28·0	N. 21·8	3 21·2	N. 23·3	5 9·2	N 22·0	7 14·4	N. 25·1	10 13·5	N. 12·5	1 34·5	N. 8·6	7 3·8	N. 22·5	21 29·3	S. 15 6

TABLE 13.

Date.	Greenwich Noon. Sun. P	Sun. B	Sun. L	Mars.	Mars. P	Mars. B	Mars. L	Mars. T	Jupiter.	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2	Midnight. Moon.	Moon. P
	°	°	°		°	°	°	h. m.		°	°	°	°	h. m.	h. m.		°
May 5 ...	−23·4	−3·6	105·7	May 6 ...	+ 3·6	+18·8	273·1	5 57 *e*	May 15 ...	−23·4	+2·6	259·7	22·2	4 54 *m*	1 27 *m*	May 5	− 2·3
„ 10 ...	22·3	3·1	39·6	„ 12 ...	5·0	19·5	216·0	9 52 *e*	„ 22 ...	23·1	2·7	283·8	352·8	4 14 *m*	2 16 *m*	„ 10	+18·4
„ 15 ...	21·0	2·5	333·5	„ 18 ...	6·5	20·2	158·7	1 8 *m*	„ 29 ...	−22·9	+2·7	307·9	323·6	3 34 *m*	3 4 *m*	„ 15	+20·4
„ 20 ...	19·5	1·9	267·3	„ 24 ...	8·1	21·0	101·2	5 4 *m*								„ 20	− 5·8
„ 25 ...	17·9	1·3	201·2	„ 30 ...	+ 9·8	+21·7	43·5	9 1 *m*								„ 25	−22·6
„ 30 ...	−16·2	−0·7	135·0													„ 30	−13·4

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-) graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter, System I refers to the rapidly rotating equatorial zone; System II to the temperate zones which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m{\cdot}6$, $9^h\ 55^m{\cdot}8$ respectively. In the case of Mars apply multiples of $24^h\ 39^m$.

The data for the Moon in Table 13 are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northward with diminishing speed. Its semi-diameter diminishes from 15′ 54″ to 15′ 48″. Sunrise changes from $4^h\ 36^m$ to $3^h\ 52^m$; sunset from $7^h\ 18^m$ to $8^h\ 4^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is an evening Star throughout the month, fairly well placed for observation. Semi-diameter increases from 3″ to 6″. Illumination, ¾ at beginning of month, three-tenths in middle, almost zero at end.

VENUS is an evening star, well placed for observation, being North of the Sun, and having passed its Elongation, 45° 39′ from Sun, on April 24th. At the beginning of May it does not set till $11^h\ 30^m$ *e*. Semi-diameter increases from 12½″ to 20″. Illumination diminishes from one-half to one-quarter. Venus is at its greatest brilliance on May 27th. It is then a crescent 36″·86 from horn to horn, and 10″·22 across at widest part.

THE MOON.—New $2^d\ 5^h\ 29^m$ *m*. First quarter $10^d\ 8^h\ 47^m$ *m*. Full $17^d\ 2^h\ 11^m$ *e*. Last quarter $24^d\ 5^h\ 16^m$ *m*. New $31^d\ 7^h\ 37^m$ *e*. Apogee $7^d\ 8^h$ *m*. Perigee $19^d\ 8^h$ *m*. Semi-diameter 14′ 47″, 16′ 34″ respectively. Maximum librations 1^d 7° S., 13^d 7° E., 15^d 7° N., 26^d 6° W., 28^d 7° S. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 15.)

MARS is advancing with increased speed, in Cancer, and afterwards in Leo. It was in opposition on Feb. 10th. Semi-diameter 3½″. Defect of illumination 0″·8. The North Pole of the planet is now turned towards the Earth and Sun. The planet is in the part of its orbit that corresponds with the second half of June on Earth. The Summer solstice of Mars' Northern Hemisphere will be reached on May 6th.

JUPITER is still too near to the Sun for convenient observation, having been in conjunction on April 1. Equatorial diameter 35″, Polar 33″.

Configuration of satellites at $3^h\ 30^m$ *m* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
May 16	4 ○	213	May 24	1 ○	31
„ 17	41 ○	23	„ 25	2 ○	31
„ 18	2 ○	413	„ 26	¾1 ○	4
„ 19	32 ○	4 1●	„ 27	34 ⊙	2
„ 20	31 ○	24	„ 28	43 ○	12
„ 21	3 ○	214	„ 29	4213 ○	
„ 22	21 ○	34	„ 30	4 ○	13 2●
„ 23	○	2134	„ 31	41 ○	23

The following satellite phenomena are visible at Greenwich all in the morning hours:—$4^d\ 3^h\ 51^m$ I. Tr. E.; $5^d\ 4^h\ 20^m\ 18^s$ II. Ec. D.; $11^d\ 3^h\ 40^m$ I. Tr. I., $4^h\ 3^m$ III. Sh. E.; $14^d\ 3^h\ 50^m$ II. Sh. E.; $21^d\ 3^h\ 47^m$ II. Sh. I.; $23^d\ 3^h\ 16^m$ II. Oc. R.; $27^d\ 3^h\ 29^m$ I. Sh. E.; $29^d\ 3^h\ 34^m$ III. Oc. D.

TABLE 14. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
R Canis Min.	7 4 2	+10 9	7·2 to 10·0	338	1916—June 12
U Herculis	16 22 2	+19 5	6·7 to 13·8	406	,, May 29
S Herculis	16 48 2	+15 5	5·9 to 13·1	308	,, May 29
R Ophiuchi	17 2 53	−15 59	6·0 to 13·6	302	,, Apr. 16
Z Ophiuchi	17 15 14	+ 1 36	7·6 to 12·6	349	,, Apr. 23
A F Cygni	19 27 40	+45 58	6·9 to 8·0	99	,, May 27
R T Cygni	19 41 15	+48 34	6·6 to 12·2	190	,, Apr. 11

Minima of Algol $2^d\ 0^h\cdot4\ m$, $4^d\ 9^h\cdot2\ e$, $7^d\ 6^h\cdot0\ e$, $22^d\ 1^h\cdot9\ m$, $24^d\ 10^h\cdot7\ e$, $27^d\ 7^h\cdot5\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.

Principal Minima of β Lyrae $1^d\ 10^h\cdot6\ m$, $14^d\ 8^h\cdot7m$, $27^d\ 6^h\cdot8m$. Period $12^d\ 22^h\cdot1$.

Eclipses of the satellites take place low left of the disc, taking the direction of the belts as horizontal.

VESTA AND JUNO.—Now that the ephemerides of the four brightest minor planets are omitted in the *Nautical Almanac*, and that the *Berliner Jahrbuch* which contains them is unprocurable in England, probably many of our readers will be glad to have these ephemerides. That for Vesta is an accurate one, by G. Stracke, from Leveau's Tables, but that for Juno is rough. Both are for Greenwich Noon :—

VESTA.

	R.A.	N.Dec.	Log r.	Log Δ.
	h. m. s.	° ′		
April 15 ...	13 35 51	3 41 ...	0·3449	0·0938
,, 19 ...	13 32 15	3 58 ...	0·3443	0·0942
,, 23 ...	13 28 42	4 11 ...	0·3437	0·0960
,, 27 ...	13 25 18	4 22 ...	0·3432	0·0990
May 1 ...	13 22 7	4 28 ...	0·3426	0·1033
,, 5 ...	13 19 14	4 30 ...	0·3421	0·1086
,, 9 ...	13 16 42	4 29 ...	0·3415	0·1150
,, 13 ...	13 14 33	4 23 ...	0·3410	0·1222
,, 17 ...	13 12 50	4 14 ...	0·3405	0·1303
,, 21 ...	13 11 34	4 1 ...	0·3400	0·1390
,, 25 ...	13 10 45	3 45 ...	0·3396	0·1482
,, 29 ...	13 10 24	3 25 ...	0·3391	0·1578
June 2 ...	13 10 30	3 3 ...	0·3386	0·1678
,, 6 ...	13 11 6	2 37 ...	0·3382	0·1781

JUNO.

	R.A.	S.Dec.	Log r.	Log Δ.
	h. m. s.	° ′		
May 5 ...	15 56 2	3 39 ...	0·5256	0·3787
,, 13 ...	15 49 42	3 3 ...	0·5256	0·3757
,, 21 ...	15 43 9	2 31 ...	0·5256	0·3759
May 29 ...	15 36 42	2 8 ...	0·5256	0·3794
June 6 ...	15 30 44	1 54 ...	0·5254	0·3859
,, 14 ...	15 25 33	1 50 ...	0·5252	0·3950

SATURN is an evening star in Gemini, and has begun to advance. It is 3½° South of Venus on 24th. Angle P−7°·0, B−25°·1. Polar semi-diameter 8¾″, major axis of ring 39″, minor 16½″. Eastern elongation of Tethys $1^d\ 4^h\cdot2\ m$; of Dione $5^d\ 6^h\cdot9\ e$.

URANUS is a morning star, but badly placed for Northern observers. It is in quadrature with the Sun on May 10th.

NEPTUNE is in Cancer. On 4th R.A. $8^h\ 8^m\cdot6$ N. Dec. 19°·9. On 28th R.A. $8^h\ 10^m\cdot5$ N. Dec. 19°·8. Semi-diameter 1″, magnitude 7·7.

METEOR SHOWERS (from Mr. Denning's List) :—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. to May ...	263°	+ 62°	Rather swift.
Apr. 19 to May 9	201	+ 8	Slow.
Apr.–May ...	193	+ 58	Slow : yellow.
Apr.–May ...	296	0	Swift : streaks.
May 1–6 ...	338	− 2	Aquarids : swift, streaks.
,, 7 ...	246	+ 3	Slow, bright.
,, 11–18 ...	231	+ 27	Slow, small.
,, 30–Aug. ...	333	+ 28	Swift, streaks.
May–June ...	280	+ 32	Swift.
May–July ...	252	− 21	Slow, trains.
,, 18–31 ...	245	+ 29	Swift, white.

Aquarids are associated with Halley's Comet.

TABLE 15. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Time.	Disappearance. Angle from N. to E.	Reäppearance. Time.	Reäppearance. Angle from N. to E.
1916.			h. m.	°	h. m.	°
May 5 ...	BD + 25°·978	6·6	9 36 *e*	118	—	—
,, 6 ...	52 B Geminorum	6·5	8 18 *e*	111	9 20 *e*	277
,, 6 ...	BD + 24°·1343	6·8	9 17 *e*	80	—	—
,, 8 ...	d^1 Cancri	5·9	11 32 *e*	136	0 22*·*m	268
,, 12 ...	WZC 705	6·6	0 44 *m*	351	—	—
,, 12 ...	388 B Leonis	6·3	11 39 *e*	107	0 43*·*m	312
,, 17 ...	π Scorpii	3·0	9 58 *e*	164	10 35 *e*	229
,, 18 ...	48 B Scorpii	4·9	0 1 *m*	34	0 27 *m*	351
,, 18 ...	65 B Scorpii	5·5	2 7 *m*	105	3 16 *m*	268
,, 21 ...	WZC 1281	6·9	—	—	0 15 *m*	288
,, 21 ...	49 Sagittarii	5·5	1 38 *m*	46	2 41 *m*	285
,, 24 ...	150 B Aquarii	6·0	2 49 *m*	100	3 43 *m*	201
,, 26 ...	22 Piscium	5·8	1 50 *m*	39	2 45 *m*	264

The asterisk indicates the day following that given in the date column.

From New to Full, disappearances take place at the Dark Limb ; from Full to New, reäppearances.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by $9^s \cdot 83$ per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones. (See Table 16.)

Observers who know Greenwich Time can use the Table to obtain their South Point.

SUN before clock May 1, $177^s \cdot 44$; May 6, $207^s \cdot 75$; May 11, $224^s \cdot 27$; May 16, $226^s \cdot 90$; May 21, $215^s \cdot 57$; May 26, $190^s \cdot 49$; May 31, $152^s \cdot 88$. These are the equations of time for the moment of solar transit at Greenwich.

TABLE 16.

Day.	Spica. S. Dec. 10° 41′.	Arcturus. N. Dec. 19° 37′.	α Coronae. N. Dec. 27° 0′.
	h. m. s.	h. m. s.	h. m. s.
Apr. 29	10 50 35·83 *e*	11 41 31·37 *e*	1 0 36·70**m*
May 9	10 11 16·74 *e*	11 2 12·31 *e*	0 21 17·72**m*
„ 19	9 31 57·62 *e*	10 22 53·21 *e*	11 41 58·69 *e*
„ 29	8 52 38·47 *e*	9 43 34·08 *e*	11 2 39·62 *e*

* Morning of April 30, May 10 respectively.

VARIABLE STARS.—Stars reaching their maxima in or near May, 1916, are included. The lists in recent months may also be consulted. (See Table 14.)

Erratum in March "KNOWLEDGE," p. 58: For Professor "*Simpson*," read "Sampson."

NOTICES.

CLASSES ON PHOTO-MICROGRAPHY.—We have pleasure in announcing that our Photographic Editor, Mr. Edgar Senior, will give a course of six practical demonstrations on Photography at the South Western Polytechnic Institute, Chelsea, on Monday evenings, from 7.30 to 9.30, beginning on May 8th. At these demonstrations special attention will be given to the photographing of etched surfaces of metals and alloys (metallography), but the course will also be arranged to suit the requirements of students of geology, botany, and so on, and of those wishing to use their own microscopes to obtain photographic records of objects. It is advisable that students joining this course should possess an elementary knowledge of photographic manipulation. Fee for course, 2s. 6d.

PRODUCTS OF GERMAN COLONIES.—In view of the progress of General Smuts' campaign in German East Africa, attention is being given by British manufacturers and merchants to the economic possibilities of that colony. In particular, the President of the Silk Association has just directed attention to the wild silk of the Anaphe silkworm, and has suggested that when German East Africa changes hands this raw silk will afford a good opportunity for British silk manufacturers. The Anaphe silkworm occurs, as a matter of fact, in many parts of East, West, and South Africa, and samples of the silk from Uganda were examined some years ago at the Imperial Institute, which introduced the product to the notice of leading silk manufacturers in this country. At that time it was doubtful whether the price British manufacturers could offer would pay the cost of collection of the scattered nests of cocoons. The Imperial Institute accordingly suggested that the Government Entomologist in Uganda should be asked to investigate the possibilities of "domesticating" the wild Anaphe, and cultivating it in plantations of the trees on which it feeds, so as to reduce the cost. This has now been found quite practicable. A new and cheap raw material for the spun-silk industry would be of such importance that it is to be hoped that energy and capital will be forthcoming for the development of this industry in Uganda, whence a certain amount of the silk is already being exported, and also in other British African colonies. Specimens of Uganda raw silk and of yarns and fabrics manufactured from it can be seen in the Public Exhibition Galleries of the Imperial Institute, S.W. In connection with the arrival in this country of the first cargo of cocoa from the conquered colony of the Cameroons, a statement that the German Cameroons was the first colony in West Africa to produce cultivated cocoa has received considerable publicity. The statement is, as a matter of fact, incorrect. Germany did not acquire the Cameroons till 1884, and five years previous to that date the cultivation of cocoa had begun in the British colony of the Gold Coast. In 1905 the advice of the Imperial Institute with regard to the preparation and marketing of Gold Coast cocoa was obtained. The Gold Coast is now the most important cocoa-producing country in the world.

THE PRUDENTIAL ASSURANCE COMPANY'S record is, as usual, one of prosperity, due to sound business management and judicious publicity. That it should have been established during such a year, however, is more than usually remarkable. The total assets show an increase of over three and a half millions sterling. The total income is £635,000 over that of the previous year, and a million and a quarter more than in 1913. There is an increase of £329,861 in the premiums of the industrial branch, and every other item, as will be seen in the report on another page, is evidence of growth in its total. How this marvellous business result is secured and maintained year by year may be realised from the speech of Mr. Thomas C. Dewey, the Chairman. He told the shareholders that the Company last summer, in connection with the American Exchange, placed all their United States securities at the disposal of the Government, and the bonds, when sent to the Bank of England, made up six motor-omnibus loads. More than forty-four thousand bonds, of a nominal value of over £8,750,000, were dealt with by a staff of one hundred within forty-eight hours. When all was finished, the Bank of England found everything in order except that a single coupon of the value of only a few shillings had in some unexplained manner vanished.